

FIG. 1 Catalytic activity per mg Pd of Pd-M (M = Ti, Zr, Hf, V Nb, Ta, Cr, Mo, W, Au) combinations towards formic acid oxidation (5 M formic acid, 0.1 M H<sub>2</sub>SO<sub>4</sub>, exposed to air) at 0.3 V vs RHE.

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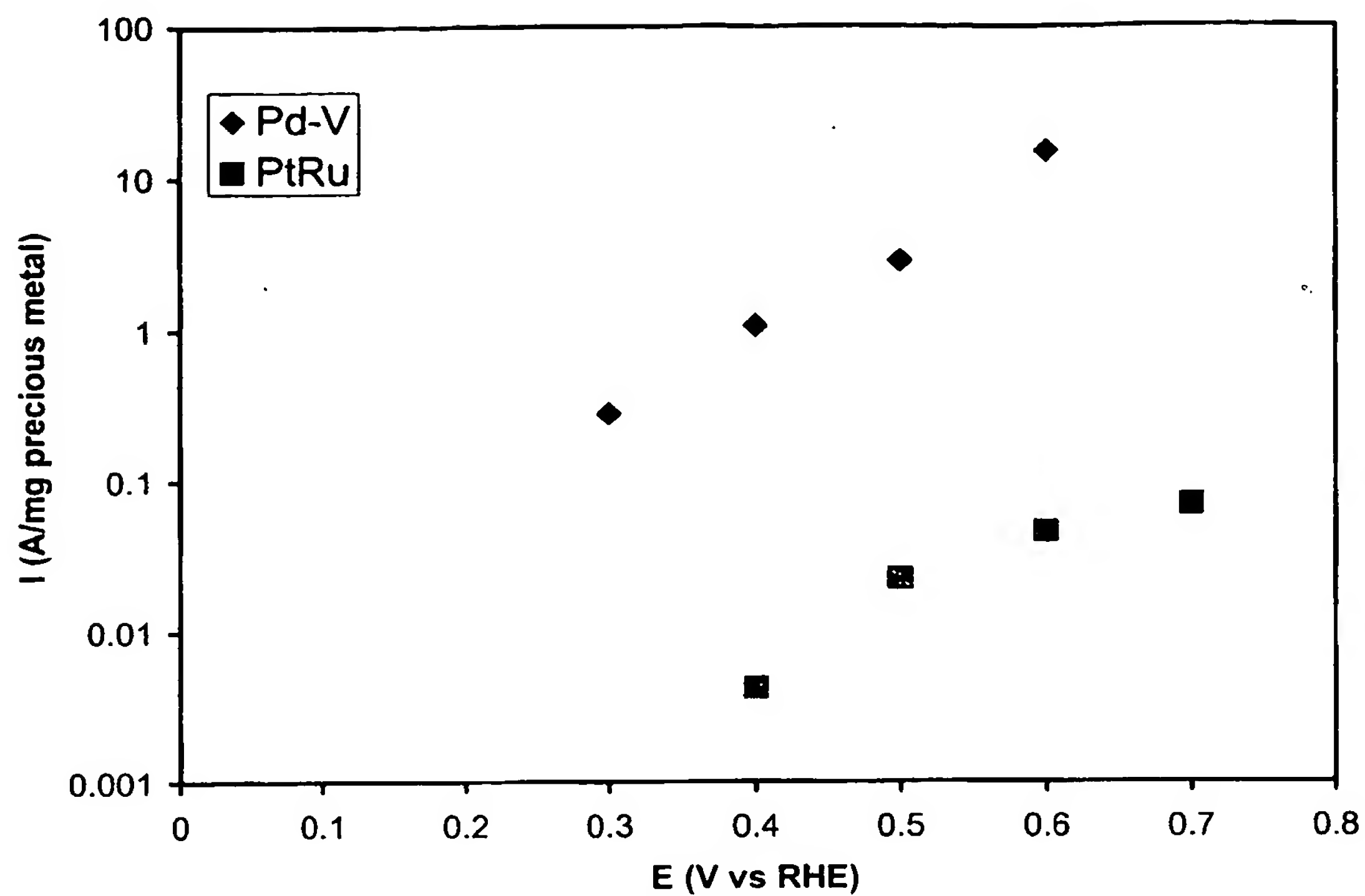


FIG. 2 - Tafel data for the Pd-V catalyst formulation compared to commercially available PtRu alloy catalyst towards formic acid oxidation (5 M formic acid, 0.1 M  $\text{H}_2\text{SO}_4$ , exposed to air, per mg Pd basis)

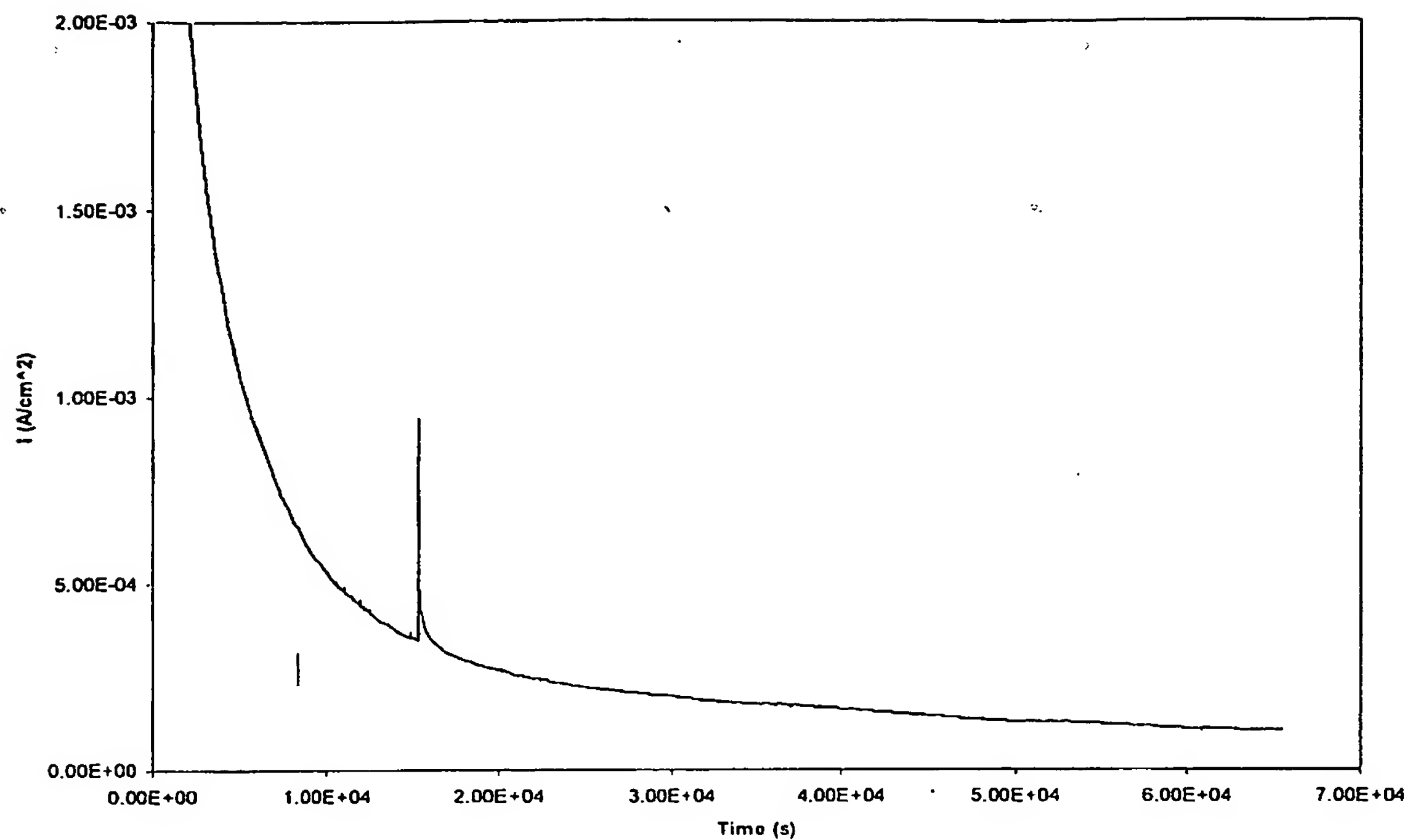


FIG. 3 - Chronoamperometric activity of Pd-V towards formic acid oxidation for 20 hours (5 M formic acid, 0.1 M H<sub>2</sub>SO<sub>4</sub>, exposed to air)

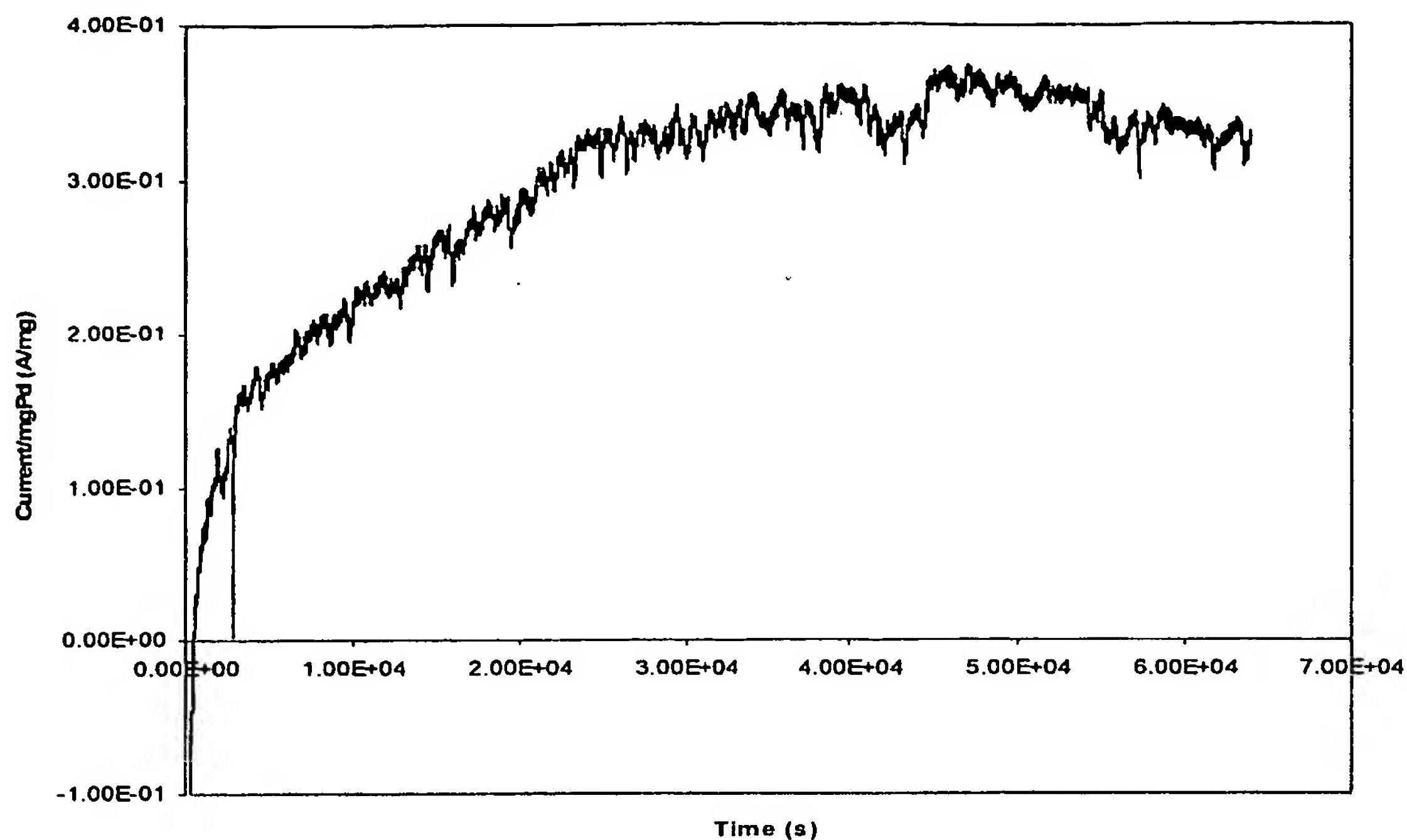


FIG. 4 - Chronoamperometric activity of Pd-V towards methanol oxidation for 20 hours  
(1 M methanol, 0.1 M H<sub>2</sub>SO<sub>4</sub>, exposed to air)

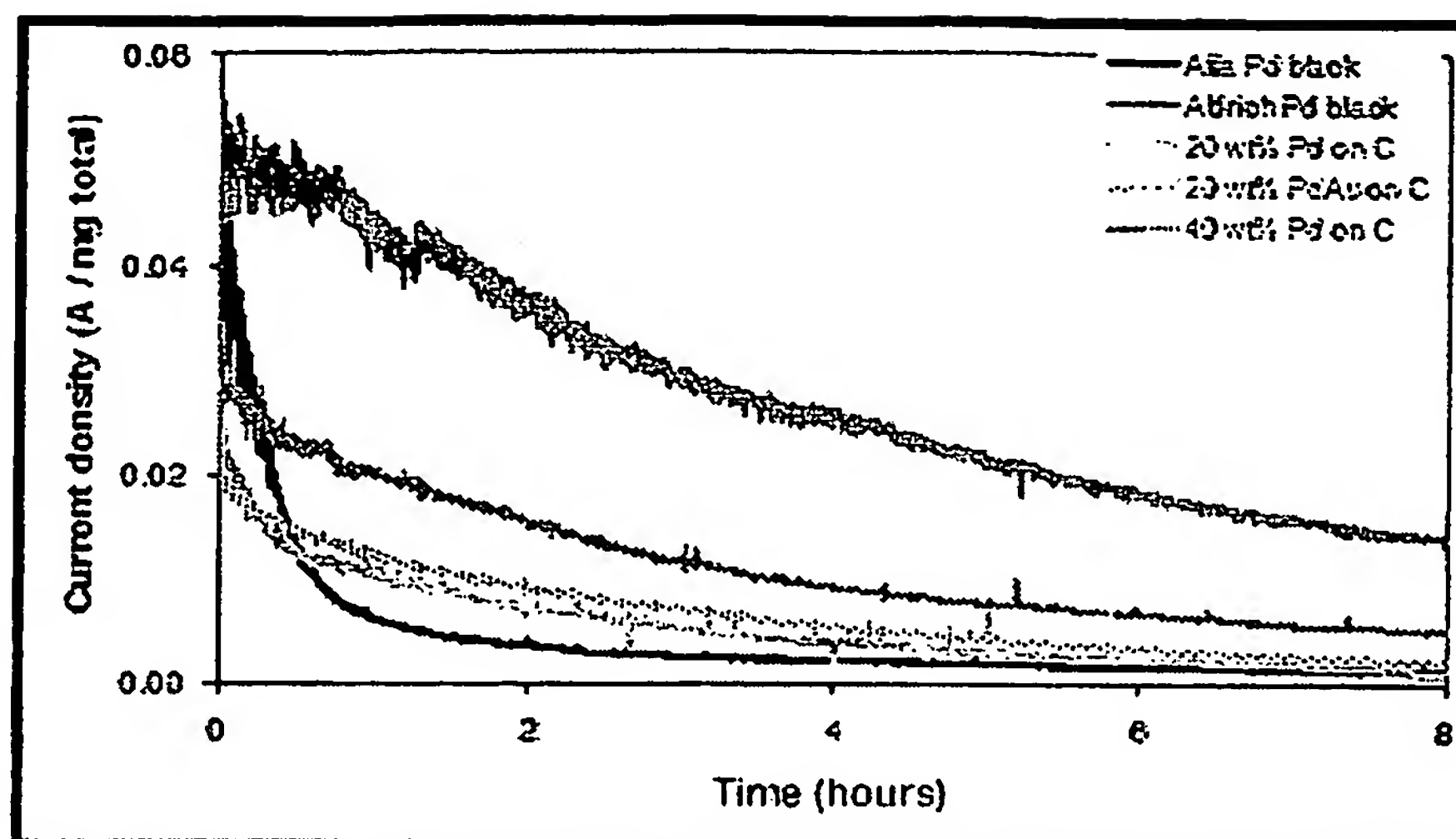


FIG. 5(A). Chronoamperometric activity of exemplary Pd catalysts at 0.3 V vs RHE (stepping from open cell) in 5 M HCOOH / 0.1 M H<sub>2</sub>SO<sub>4</sub> exposed to air. Current densities are based on total catalyst weight.

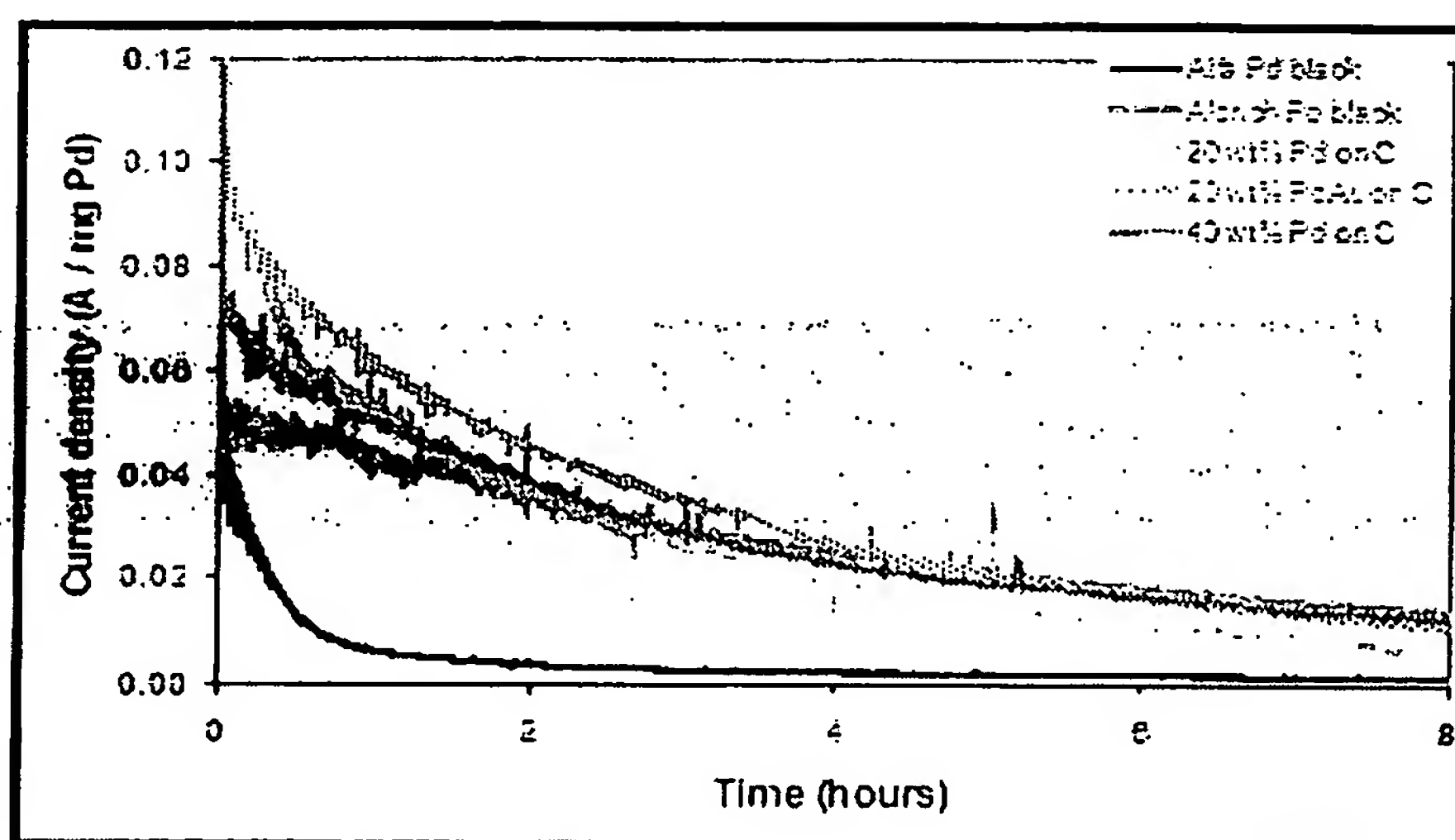


FIG. 5(B). Chronoamperometric activity of Pd catalysts at 0.3 V vs RHE (stepping from open cell) in 5 M HCOOH / 0.1 M H<sub>2</sub>SO<sub>4</sub> exposed to air. Current densities are based on Pd weight.

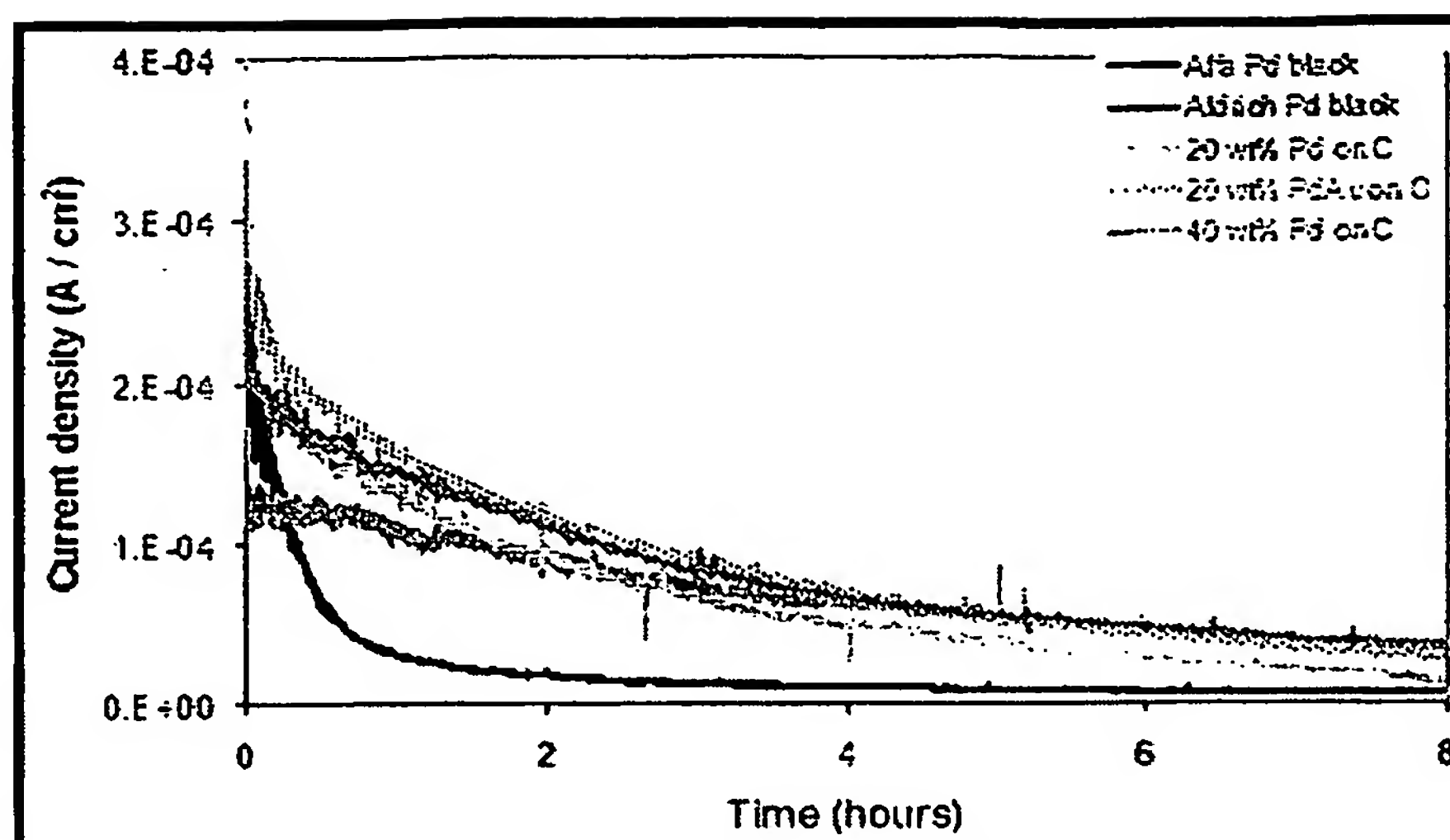


FIG. 5(C) - Chronoamperometric activity of Pd catalysts at 0.3 V vs RHE (stepping from open cell) in 5 M HCOOH / 0.1 M H<sub>2</sub>SO<sub>4</sub> exposed to air. Current densities are based on active catalyst surface area.

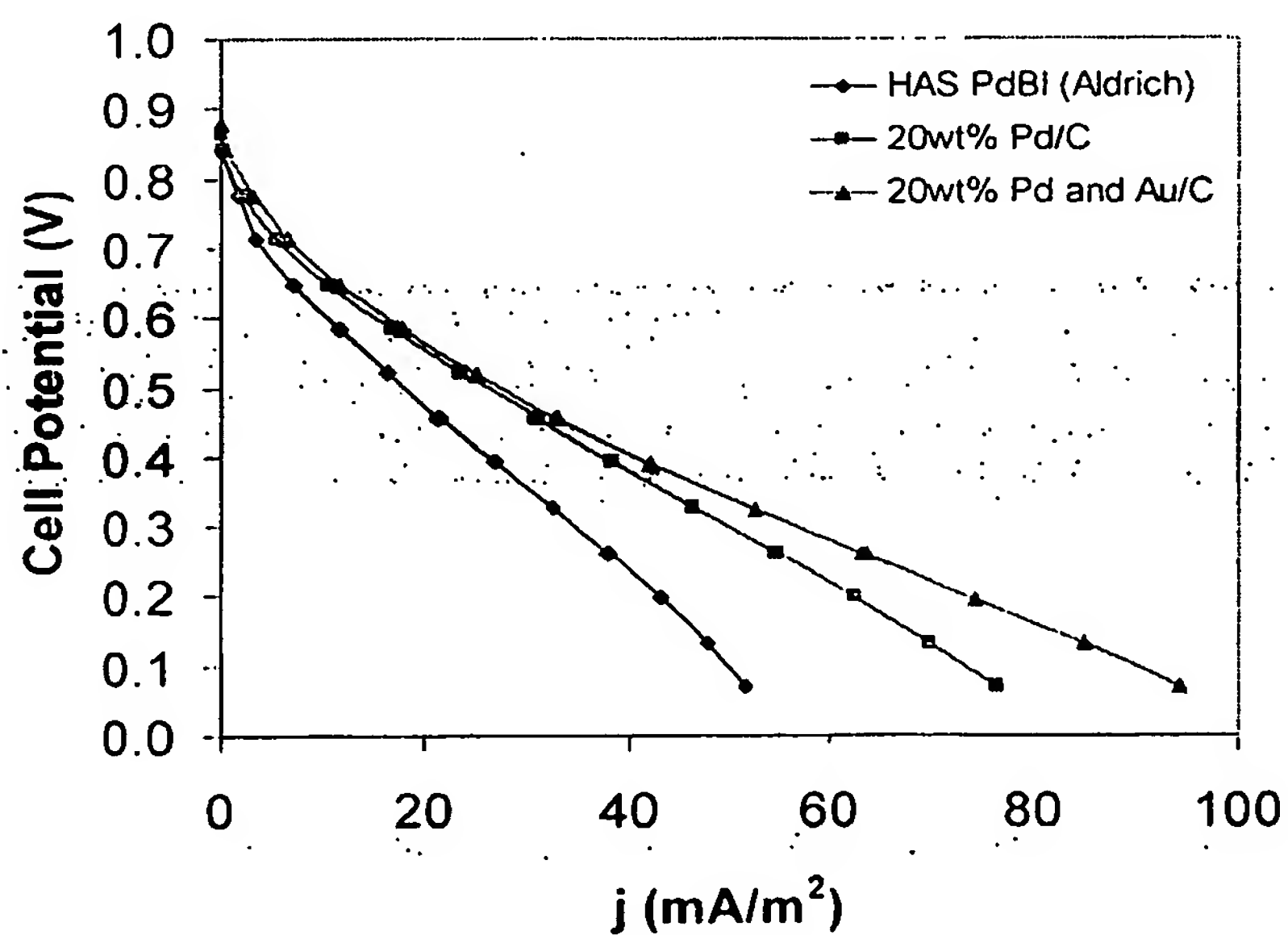


FIG. 6 - VI plots using 5 M formic acid and dry air at 30°C. Total currents are normalized by total geometrical active surface area.

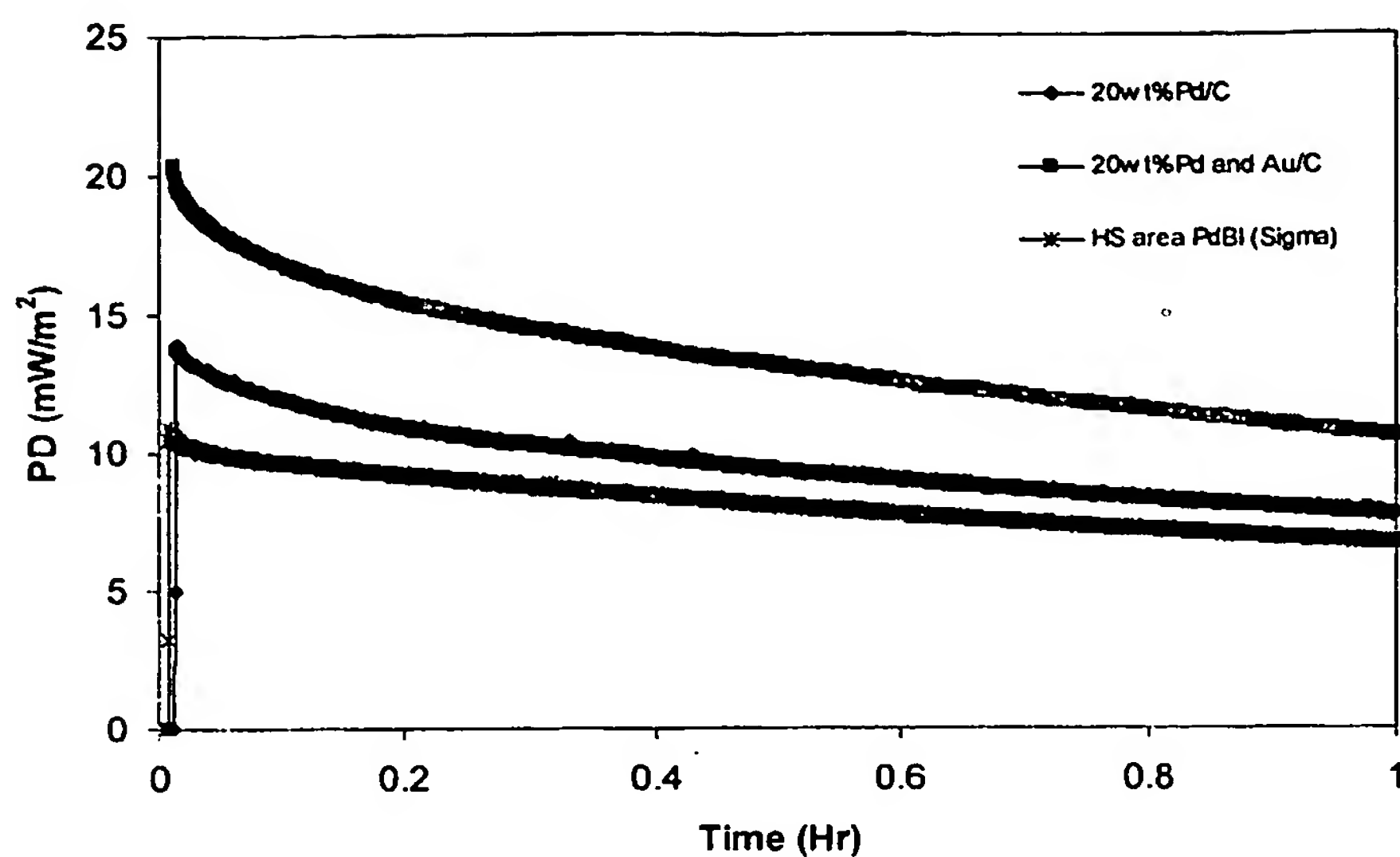


FIG. 7 - Constant voltage test using 5M formic acid and dry air at 30°C. Total currents are normalized by total active surface area.

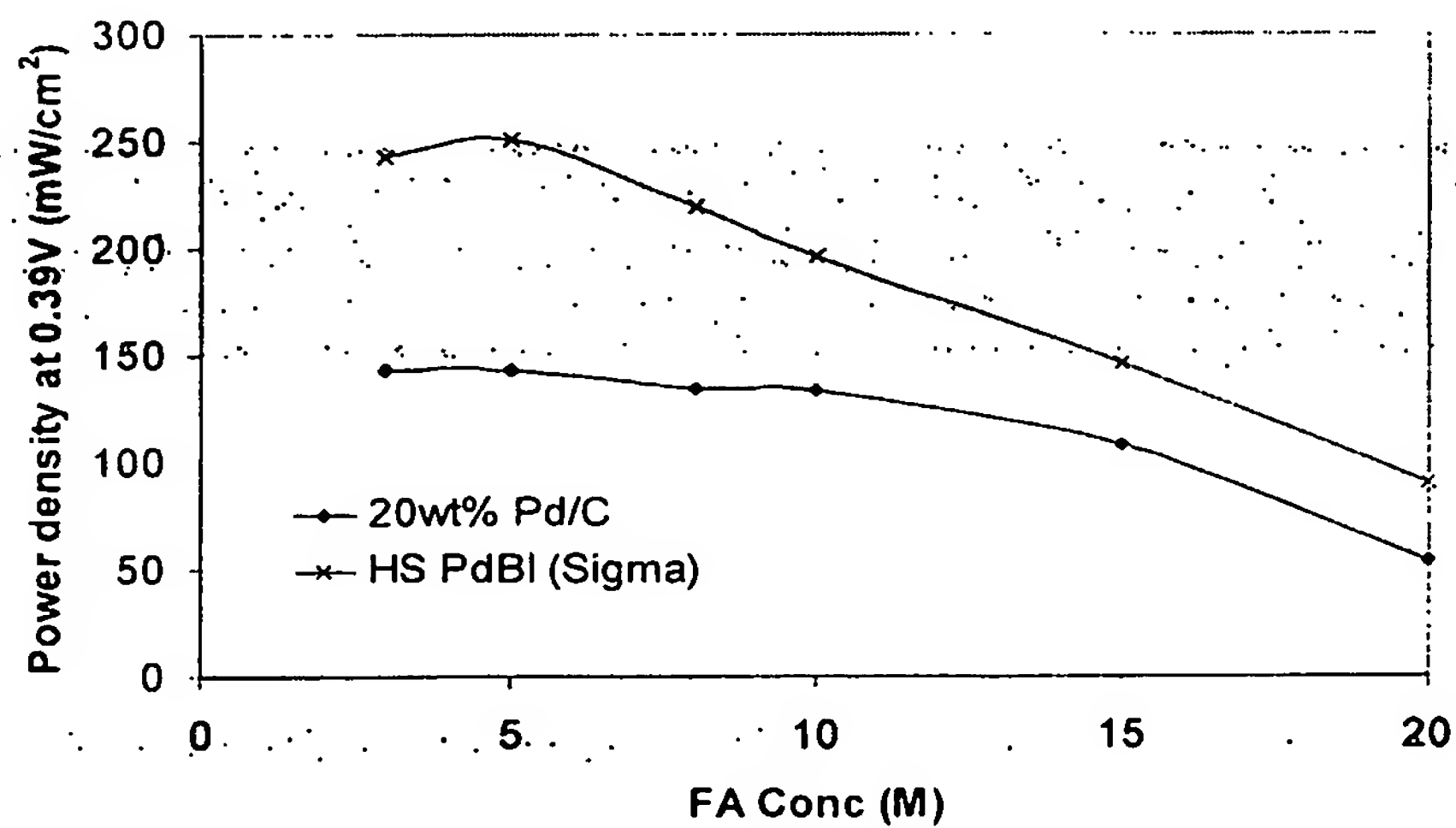


FIG. 8 - Plot of formic acid feed concentration vs. power density at 0.39 V cell potential. The cell temperature was 30°C. Power is normalized by geometrical active surface area.

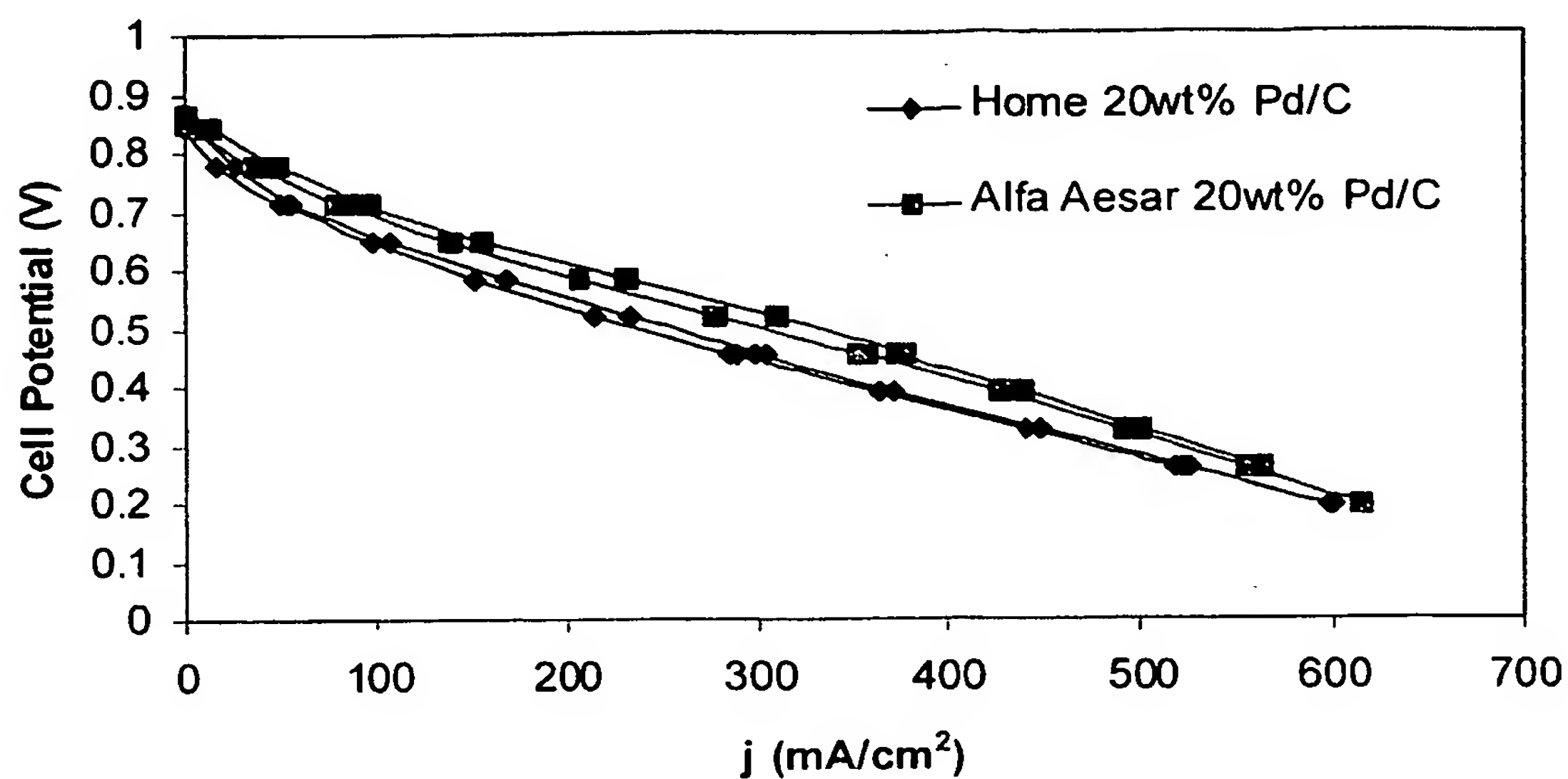


FIG. 9 - 5M Formic Acid Fuel Cell Performance. "Home 20wt%" is synthesized 20 wt% Pd on C, and "Alfa Aesar 20 wt%" is commercially available.



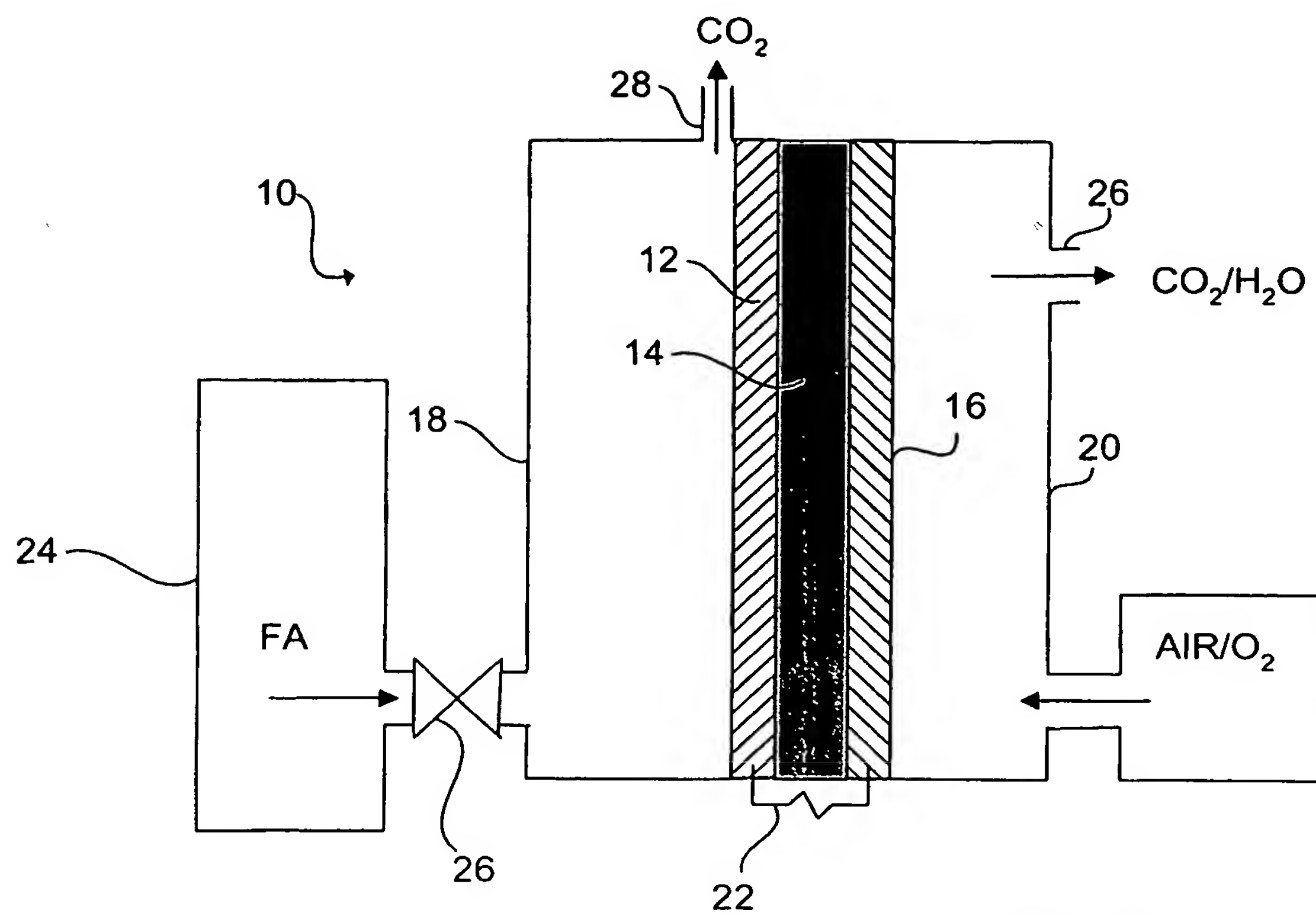
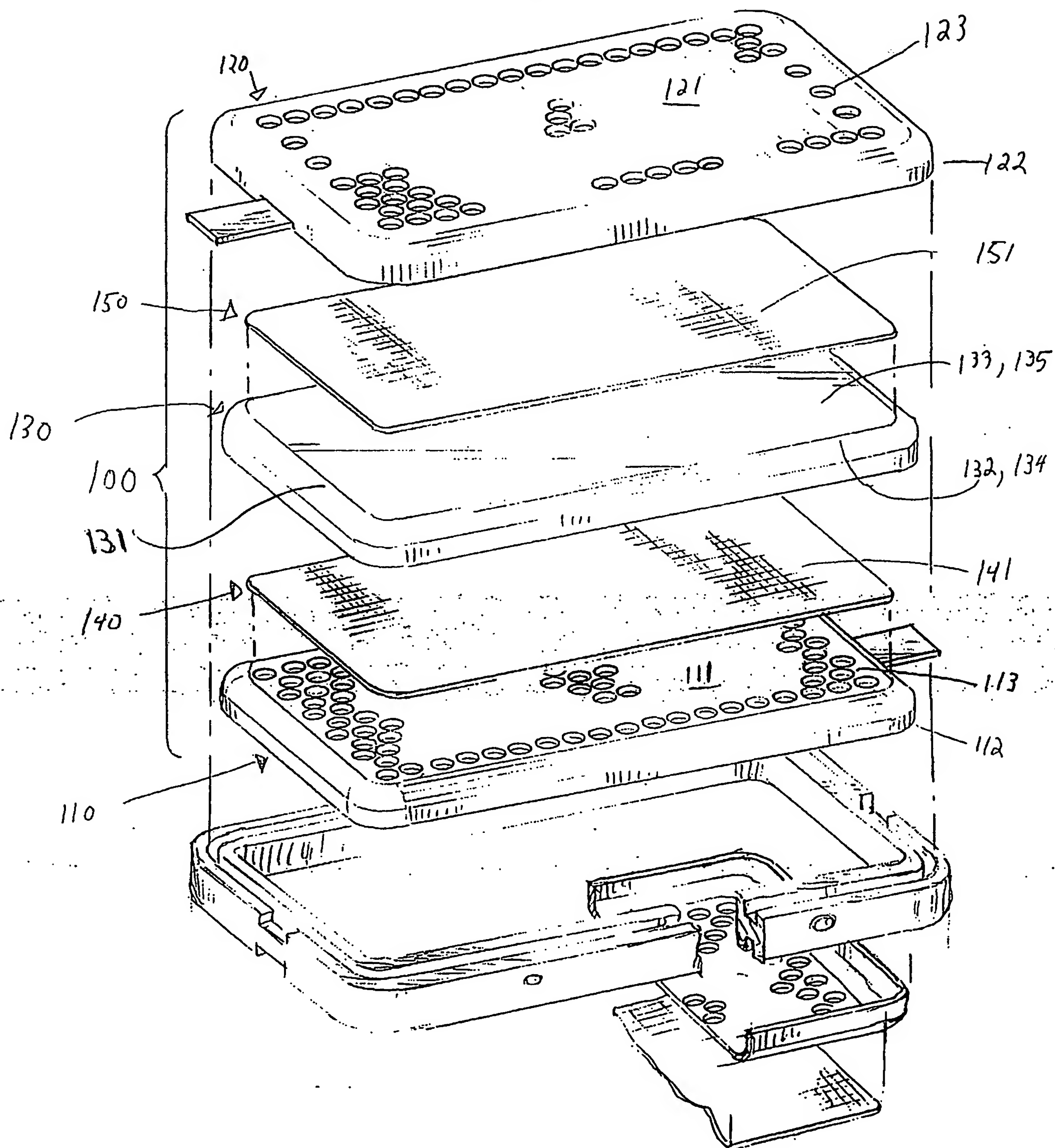


FIG. 10

FIG 11



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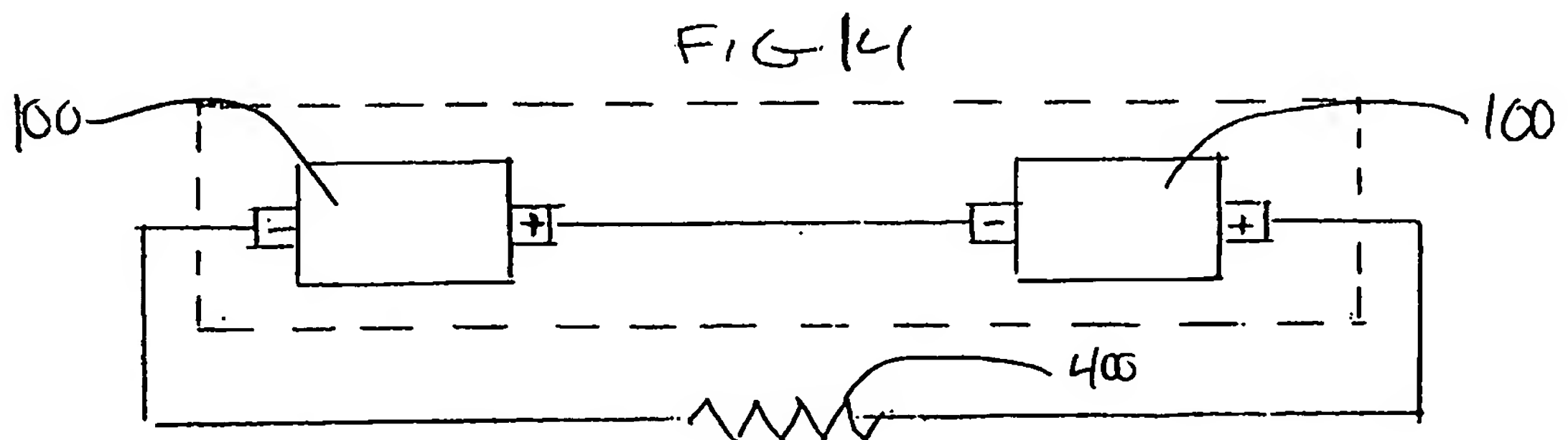
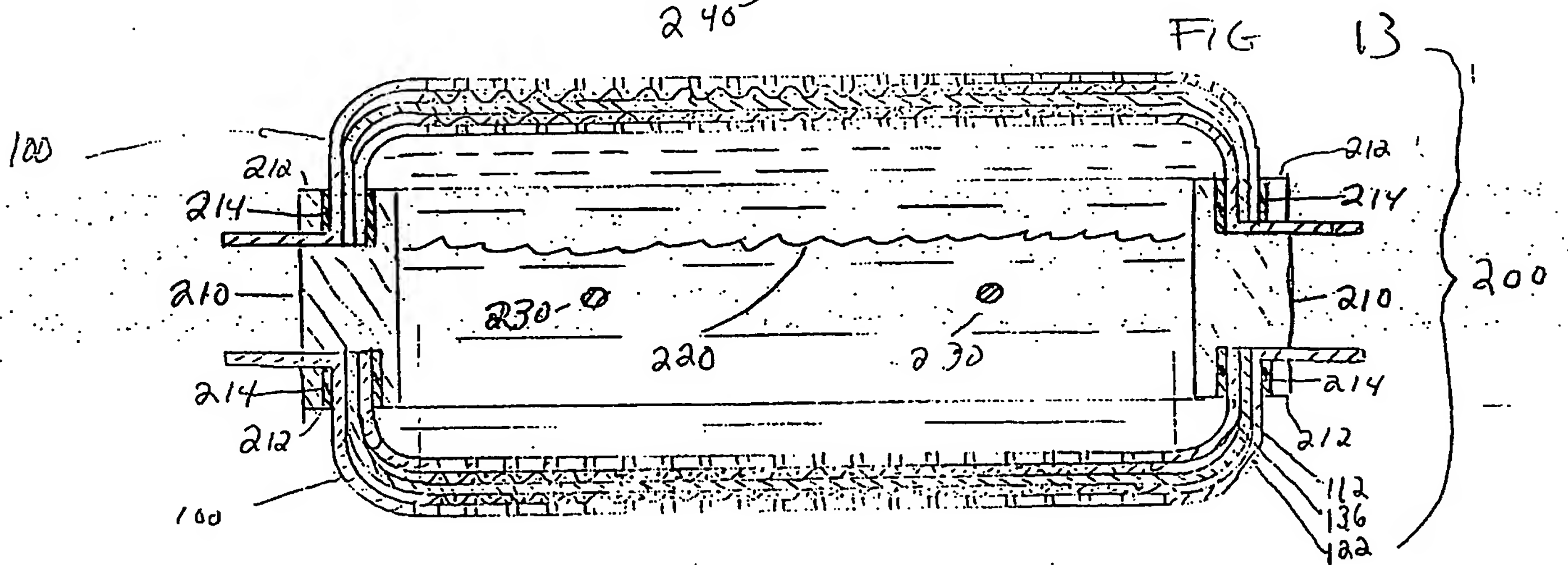
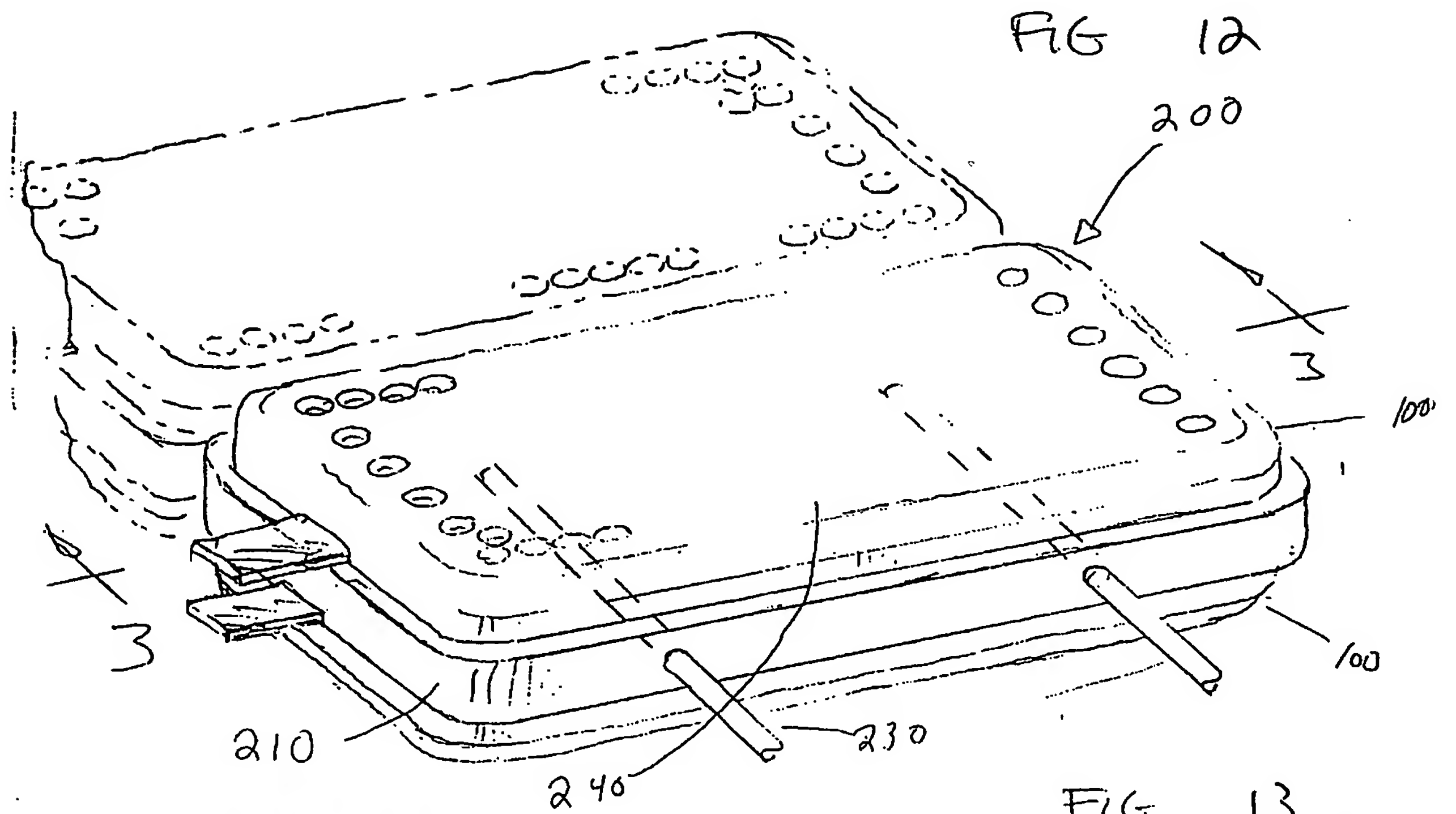
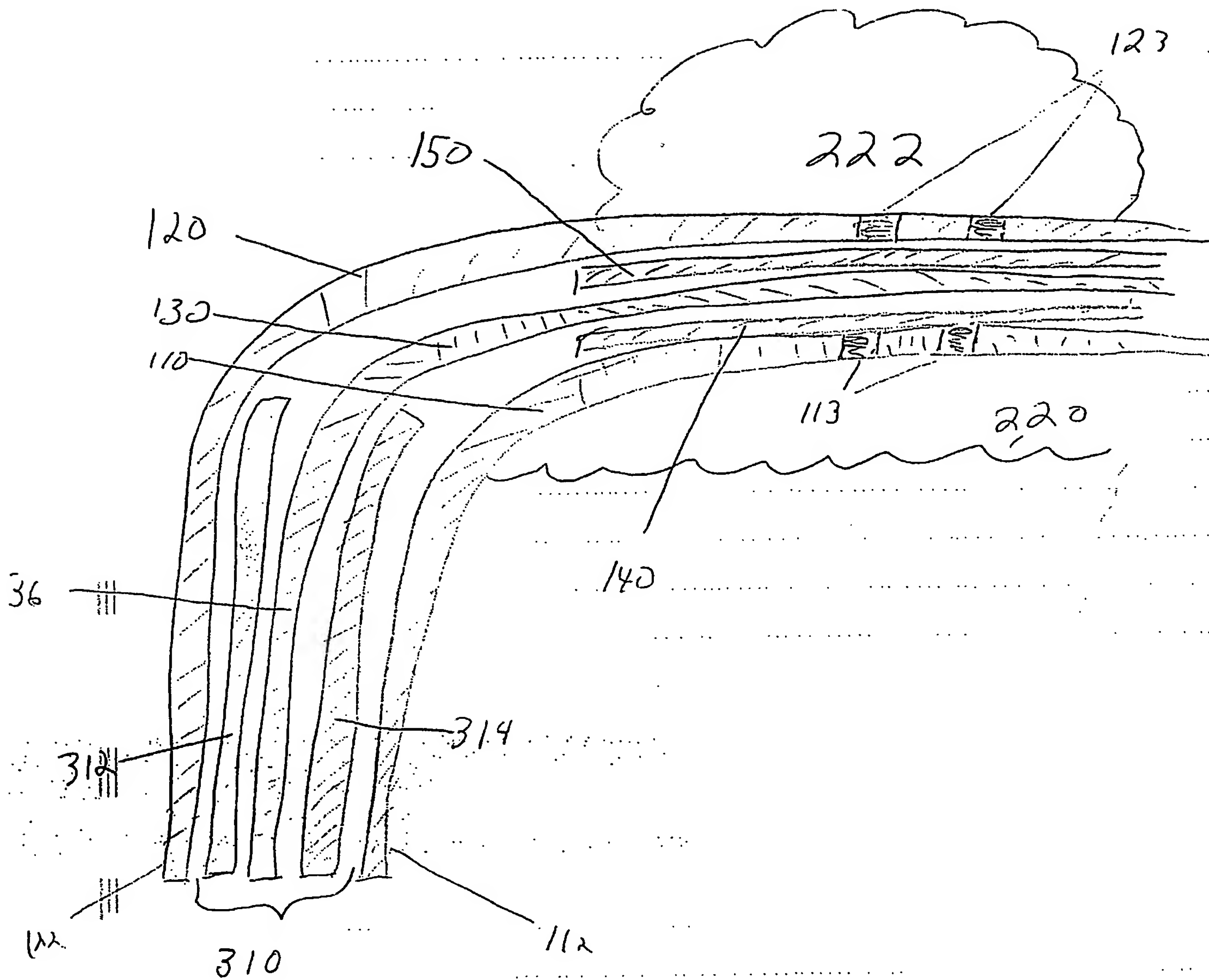


FIG. 15

FIG. 15



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